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Bt from Sotheran

THE

ROAD-MAKER'S GUIDE,

INCLUDING

A STATEMENT OF THE BEST MODES,

FOR THE CONSTRUCTION OF

New Roads, Pavements, &c.

ILLUSTRATED BY AN

EXPLANATORY COPPER-PLATE;

TOGETHER WITH

Instructions for amending many Inconveniences,

ATTENDANT ON THE PRESENT STATE THEREOF;

AS ALSO,

RULES for the IMPROVEMENT of FENCES.

BY R. R. BRAMLEY, ESQ.

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TO

W. WILBERFORCE, ESQ; M.P.

FOR THE COUNTY OF YORK.

SIR,

THE following Treatise on Road-Making, which, having stood the ordeal of practice, may prove of essential service; I beg leave to address to you, as a friend to every improvement that interests mankind, and as a memorial of that regard which a long knowledge of your attention to the general weal, and to the particular interests of your constituents, demands from one to whom you have shewn repeated marks of friendship,

And who has the honor to be,

Sir,

Your most obedient Servant,

Rd. Ramsden Bramley.

PREFACE.

So many of the Enjoyments of Life depend upon an eaſy mode of conveyance, and ſo much of its pleaſures in travelling on the convenience of good Roads, that the Author flatters himſelf, with the welcome reception of an eſſay, which he hopes will prove of general utility. Its intention is to point out the errors moſt uſual in the Roads already conſtructed in this kingdom, to explain to every capacity the cauſes whence thoſe errors originate, and where they exiſt, he endeavours to ſhew the eaſieſt and leaſt expenſive mode of removing them, and of preventing and amending them in future.

It attempts further to elucidate and explain the principle which it is neceſſary to follow in the formation of New Roads, ſo as to make them durable and uſeful at

the eaſieſt expence, claſſes the materials employed in the conſtruction of roads, proportionably to their uſe and duration, and wiſhing only to be ſubſervient to real utility, a conſtant endeavour has been purſued throughout, to avoid every term not intelligible to the common ſurveyor of a public road.

The beauties which ariſe from ſeeing grounds well fenced, and the pleaſing effect of fences kept in good order, will, it is hoped, apologiſe for having pointed out a mode by which they may be kept univerſally in good repair, and at the leaſt expence; whence a conſiderable ſaving will likewiſe accrue to the farmer, as ſhould this plan be purſued, a clearance of twenty-ſeven to thirty-ſix inches in width, from waſte, would become fertile on each ſide of moſt hedges in this country.

THE

ROAD-MAKER's GUIDE.

PRELIMINARY OBSERVATIONS.

THE firſt principle apparently impreſſed by Almighty Power upon all inert matter, is a tendency to become proper for the ſyſtem of vegetation, which the obſerving eye will diſcover in the change of every the moſt ſolid body, when the elements are allowed to have their full influence thereon. From this cauſe it becomes the proper ſtudy of the Road-Maker, to ſelect ſuch materials for that uſe, as are moſt diſtant from the capacity of ſupporting vegetables; and reaſons for the preference of various ſpecies are adduced in the ſequel.

Situations will frequently occaſion the moſt durable materials to coſt a ſum ſo much more conſiderable, than a ſupply of the inferior kinds; that prudence here muſt dictate the choice.

One

One obſervation is however neceſſary to be made; that nature having made water the apparent diſſolvent of all hard ſubſtances, (thus accompliſhing moſt readily her primary end) it ſhould be the firſt care in planning Roads, to form them ſo as to diſcharge all moiſture in the readieſt manner poſſible, and never to admit water to reſt on any part thereof. To accompliſh this great end, a general rule is laid down for the formation of roads of various breadths, uniting the power of reſiſtance to preſſure, with a ſufficient ſlope to quit the water which falls thereon.

Long obſervation and extenſive experience have proved the truth of the poſitions here laid down, and the proof of their utility induces the author to make them generally public.

On

On Road Making.

ALL knowledge being the reſult of obſervation, which teaches the mode of applying the ſame by fixed rules to its proper uſe, we ſhall beg leave to ſuppoſe the following data reſpecting Roads, and their formation, as axioms deduced from practice.

The firſt object deſirable in roads, is undoubtedly facility of conveyance; the ſecond to continue the duration of that facility.

The attainment of the knowledge requiſite to gain thoſe advantages, including an acquaintance with chymical combination in the choice of materials, and mechanical ſkill in the mode of application, requires ſuch rules, as, when applied, ſeem likely to attain the deſired end; hence, from long obſervation, it is inferred, that the probable cauſe of the extraordinary duration of particular ſpecies of ſtone for Roads, ariſes from the peculiar materials of which they are compoſed, as their abſorbency of water is conformable to ſuch their

their original compoſition, and in proportion to ſuch abſorbency, moiſture, and more particularly froſt in cold ſeaſons, acts with greater rapidity in their decompoſition, or the approach to that medium, to which Providence has ordained that all matter ſhould ultimately tend, when expoſed to the atmoſphere.—That is the formation of a nidus, or ſituation proper for the exiſtence of vegetable life.

This peculiarity has hitherto claimed little attention, but the later diſcoveries of chymiſtry ſufficiently account for the particular tendency to decompoſition ſo evident in many ſpecies; although as yet it ſeems not completely to account for that of ſeveral others.

Stones when decompounded, appear to have been compoſed in various proportions of *Silex* Sand, *Argil* Clay, and *Calca* Lime, with a combination of metallic compounds in unnumbered gradations.

The capacity for abſorption of the unmixed earths, of which ſtones are compoſed, is of ſand; when pure, the fourth part of its weight of water; of pure lime, the one half of its weight, and of pure clay, two and a half times ſuch weight.

The effect of froſt on water is to buoy or ſwell up that portion thereof, on which it has full effect, in the ratio of one eighth its bulk, or from the ſize of eight in its original, to that of nine in its frozen ſtate. Hence

Hence when after a period of froſt a thaw takes place, the frozen materials decompoſe, or crumble into ſmaller particles, and we ſee that moſt roads are covered with a thinniſh pappy cruſt, conſiſting of ſuch materials as were ſubjected to the effect of froſt, and in quantity generally proportionate to the peculiar abſorbency of the material, is the exceſs or ſmall degree of the damage ſuch weather occaſions, yet none is entirely exempt from ſuch effect.—Where a conſtant ſucceſſion of carriages at ſuch ſeaſons, by their friction, occaſion the diſplacing of the ground work, there the road conſequently ſuſtains a greater proportionate damage, as ſuch motion expoſes a much greater portion of materials to the influence of the atmoſphere than has place in roads little frequented at ſuch ſeaſons, and where the original external ſurface alone ſuſtains the detriment.

Hence it is, that of all the materials uſed for the formation of roads, thoſe ſtones, the component parts of which conſiſt ſolely, or nearly, of pure ſilex or ſand, continue, when ſuch ſtones are in their origin cloſely granulated, moſt permanently durable.

Such is the compoſition of the better kinds of flint whoſe component parts are nearly pure uncontaminated ſand, and whoſe adheſion is conſequently ſo cloſe, as barely to admit the penetration of water into its minute interſtices ; deſcending in the ſcale,

ſeveral

ſeveral ſpecies of flint include, or are compoſed, along with ſilex, of ſmall proportions of lime and clay, and in ſuch proportion as thoſe extraneous objects become proportionate parts of the whole ſubſtance; and, agreeably to their ſtated powers of abſorption, ſo are thoſe materials more or leſs proper for uſe, and their duration a compound of the greater or leſs facility of abſorption, to which the original compoſition is liable.

Sparry materials, and chert or ſtones compoſed of ſand and lime in varying proportions, although not generally found, yet are in the firſt claſs of utility, but thoſe are rare, as is the Terraponderoſa, which would elſe claim a priority to moſt for its utility as a material for roads.

The hard ſpecies of ſtone known commonly in many parts of the kingdom by the name of Caillards, is principally compoſed of ſilex, and may be claſſed in the next gradation of utility. The reaſon for which ſuperiority ſeems to ariſe from its cloſe coheſion, and conſequently ſlight tendency to abſorption, when by attrition beat into ſmaller particles. Whin ſtone, abounding with thoſe peculiarly rounded ones, whoſe compoſition is nearly pure ſand, probably claſſes in the next gradation; ſuch rarely contain proportions of clay ſufficient to make them conſiderably abſorbent.

Lime-ſtone

Lime-ſtone, when of the harder and granulated marble ſpecies, follows in the next gradation, as its particles form one of the next coheſive materials, to that of the ſtones compoſed of ſand nearly pure, and its nature admitting only the abſorption of one half of its weight of water, gives it a conſiderable preference over any other ſpecies of ſtone, whoſe peculiar combinations admit of varying proportions of clay in their original ſtate. Yet, as many of the varieties of lime-ſtone particularly the laminated ones, are compoſed of varying proportions of lime, ſand and clay, thoſe of the latter kind prove often very unfit, comparatively, for the uſe of roads, although, on account of cheapneſs of acquirement, they may not unfrequently be found of conſiderable utility.

Stones, which in their combination retain conſiderable proportions of metallic matter, are durable in compound ratios, viz.—Firſt, of their original compoſition, as approaching to the nature of pure ſand, or of pure lime; and next to the tendency to decompoſition of the metallic matter they contain. Gold and ſilver have little of ſuch tendency; but in Europe ſuch ſtones are rare.—Tin likewiſe has very ſlight tendency to ſeparation, nor has lead much thereof. Copper diſſolves when expoſed to the atmoſphere, with much greater facility, and the ſtones in which it generally abounds, more frequently contain conſiderable proportions of clay. But the kind leaſt uſeful in

proportion to its apparent hardneſs and its ſpecific gravity, is that which abounds with iron; the local ſituation in which that metal is found, is generally in ſtones of the ſchiſtus kind, conſiſting in great meaſure of clay, and the metal in ſhelly layers, which ſtones expoſed to the open air, ſplit or divide into minute particles, when their component parts ſeparate into their ſpecific ſtates of calx of iron, and (the general union of clay and ſand called) clay, as ſuch earth makes a conſiderable part of the compoſition.

Stones which contain calamine, emery, &c. containing generally conſiderable proportions of *Silex* ſand, or *Calca* lime, united with thoſe ſemi-metals which are not of eaſy ſolution, are generally uſeful for the purpoſe of road-making.

Moſt other ſpecies of ſtone, including in their combination, conſiderable proportions of clay, are, in conſequence of its tendency to abſorption, not nearly ſo properly applicable for the deſired uſe as the earlier deſcribed ones; yet on account of the local ſituation, are, as ſaving expence of carriage, &c. frequently applied to the making of roads. Where the former ſpecies are not to be procured, unleſs with very increaſed expence, thoſe may conſequently be often uſed with propriety; yet it ſhould ever be the Road-Maker's ſtudy, to procure if poſſible, the better kinds, and in the deſcending ratio, to be particularly attentive

tive, as far as in his power, to avoid the uſe of every ſpecies, whoſe component parts conſiſt in any conſiderable proportion of *Argil* clay, of which a leſs proportion than one ſixth part, will rapidly tend to diſunite the whole, and in rainy or froſty weather, ſoon reduce the ſame to an apparently ſaponaceous greaſy maſs.

Sand, although compoſed generally of ſuch particles, as when coheſive, form the beſt material for roads, is rarely found free from proportions of clay, or of vegetable earth, and that, in portions too conſiderable to make its application deſirable, where better materials are eaſily attainable. Were the whole to be waſhed, and the argillaceous and the earthy matter (which readily diſſolves) floated off, the ſame might in many ſituations be of much greater utility than its preſent application would imply, as although its minute particles reſiſt not the impreſſion of conſiderable weights as might be wiſhed, yet the ſlight tendency to abſorption, and the facility of replacing the materials when deranged, would thus occaſion an uſeful application, where the preſent mode is a ſource of conſiderable inconvenience, and of much uſeleſs expence.—This particular remark is applicable, in a conſiderable degree, to all the roads around London, where the general material applied, is either gravel compoſed of ſilicious and clayey materials, in which the

the latter is too abundant; or of original flints intermixed in a bed of thoſe materials, and where too conſiderable a proportion of the latter is intermixed with the flinty materials, which alſo originally poſſeſs ſome portion of clay in their compoſition, as not being of the pureſt ſpecies. Where materials of this deſcription are uſed, the beſt mode would be to immerſe, (on the ſpot where procured) the whole original maſs in water, and in ſuch manner to ſhake or roll the ſame therein; as by means thereof, to diſſolve the whole, or nearly the whole of the adheſive clay, which mixing ſoon with water, would thus be readily floated off; (the expence, as water is generally near, would not prove conſiderable) and leave the remainder in a ſtate much more proper for the deſired uſe, as being thus freed from that peculiar ſubſtance, which induced premature decompoſition from its particular tendency to abſorption.

Compoſite Materials.

AS the ſlag of iron furnaces, the refuſe of glaſs-houſes, clay and ſtones burnt in their native ſtate, or the former compounded into bricks and burnt nearly to vitrification, may frequently be applied with advantage to roads, but obſervation brings the conviction, that none of theſe materials prove very durable, where heavy carriages are employed; what appears to anſwer beſt of thoſe artificial materials, is the ſlag or cinder

cinder of the old bloomeries, (or iron works) which remain in many ſituations, and whoſe uſe is generally there adviſable. Apparently wood, as formerly uſed, when made into charcoal, for the ſmelting of iron, forms with that metal, a ſlag of greater durability, than that of the preſent mode, in which foſſil coal is generally applied.

N. B. Where iron or coal is abundant, there moſt generally the ſtones in ſuch vicinity abound, with too conſiderable a portion of clay to prove uſeful for roads.

Clay and vegetable earth are apparently nearly equal as to their powers of abſorbency, conſequently equally liable to that expanſion which froſt is ſure to occaſion at certain ſeaſons in Northern climates, and liable to revert rapidly to that ſtate of diſunion, which unfits them for materials for roads; it becomes therefore neceſſary to adviſe, that wherever any applicable materials, whether in the form of ſtone, gravel or ſand, contain in their compoſition, much, or even moderate proportions of thoſe earths; then, that if better are attainable, ſuch ſhould not be applied, and that conſiderable ſaving in expence indeed, can alone warrant ſuch application, which includes the carriage of the ſupply for, and the carrying off the decompoſed materials of ſuch road, as well as a long train of expences which the heavy ſtate of the roads occaſion, from the increaſed power required to drag the carriages forward

ward, and the irregular application of ſuch power, which alike injures the animals employed, and induces immenſe expence in the extra repairs of carriages.

Having laid down rules for the choice of materials moſt proper for roads, the next neceſſary one will be to fix the mode of application, and here the flinty materials in many inſtances, being naturally formed of ſuch proportionate ſize, as to allow only ſmall interſtices when thrown together, require only that of the rule afterwards laid down for form.—Where thoſe flints are of a ſize larger than the egg of a pigeon, or that of a ſmall Bantam fowl; there the application of the hammer ſhould reduce them ſo as not to exceed ſuch ſize. And, with the ſtricteſt propriety may this principle be laid down as a general rule, applicable to the materials proper for uſe in roads of every deſcription, and of every varying material. The reaſon why, is, that when the materials for roads are intermixed of irregular ſizes, there the preſſure of the weights rolling on them, can with facility, bruiſe or preſs together thoſe portions whoſe diviſion into ſmall pieces requires only the application of moderate force, to make the ſeparated particles join in intimate union, whilſt, where the materials are (as all ſhould be if attainable) of cloſe and adheſive texture, thoſe particular ſtones, which in any conſiderable degree exceed the ſize noted, are in conſequence of their native texture, ſo adheſive, as to poſſeſs the capacity of reſiſtance to all moderate

derate weights allowed on roads; and thence remain unchanged in the ſtate originally applied, leaving beneath and around them, interſtices into which water ſubſides, and reſting there, ſoftens all around them where there are vacancies for its admiſſion. Although thoſe particular large ones themſelves, until made ſmaller by art, are capable of reſiſting its influence for conſiderable periods of time, as alſo of every weight rolling thereon; from which cauſe they not only occaſion damage to the road in its original formation, but whilſt ſuffered to remain, continue the original evil ſucceſſively to every new ſupply of materials which are required for the reparation of ſuch road.

Other evils of conſiderable importance ariſe from the uſe of materials not reduced to ſmall ſizes, which are the danger incident to every riding horſe going thereon, and from hence many of the diſaſters originate, which occur to the rider on ſuch roads; ſuch ſtones alſo occaſion, wherever they become fixed, new obſtacles of reſiſtance to all wheels uſed thereon, conſequently requiring additional power to overcome ſuch reſiſtance, and when overcome, occaſioning the ſame wheel to drop down with increaſed velocity, and conſequently with ſo much of added force, as to occaſion the expence of conſiderable and renewing repairs, where the removal of the original evil would generally remedy the defect. The ſhock occaſioned by this means

to

to the carriage, induces a very conſiderable expenditure more than neceſſary in its repair, and ſhortens conſiderably its duration: the injuries likewiſe which the tire herein ſuſtains are incomputable, but aſſuredly of moſt extenſive detriment, without adverting to the additional force required from the whole team, to empower it to overcome thoſe artificial difficulties.

Obſervation induces the ſuppoſition, that the ſemicircular form can moſt permanently reſiſt the influence of the weather; yet, its uſe in roads is precluded by the impoſſibility of travelling with facility on any part thereof, except near its centre; conſequently a form including each advantage is deſirable, and a variety of practical obſervations prove to the author, that where roads extend to the breadth of twelve yards, there the height of twelve inches is an adequate and the moſt uſeful elevation; that ſuppoſing this the ſegment of a widely extended circle, then the ratio of ſuch elevation, will be the rule deſirable for roads of narrower breadths, and the ſcale laid down as under will apply to all.

Elevation of the Centre on Roads.

WHEN two yards wide, one inch and a half. When three yards, two inches.—Four yards, two inches.—Five yards, two inches and a half.—Six yards, three inches.

inches.—Seven yards, four inches.—Eight yards, five inches and a half.—Nine yards, ſeven inches.—Ten yards, eight inches and a half.—Eleven yards, eleven inches and a half.—Twelve yards, twelve inches.

The Mode to be purſued in the Choice of Ground for a Road.

THE firſt requiſite here is to make choice (where poſſible) of land, whoſe baſe is firm, not ſubject to ſoft or boggy places.

II. That the ſame be free from ſprings, or that where ſubject thereto, care be taken to unite thoſe ſprings into general heads, and detach them by drains on the higher ſide of ſuch roads, ſo as that their moiſture can never affect the ſame.

III. That ſuppoſing the ground work, or baſe, ſtony, or that ſtones are intermixed therewith, all ſuch ſhould be removed prior to laying on materials, and that none larger than the ſize propoſed, ſhould be included within the bed of the road, to the depth of nine to twelve inches.

When the Ground is ſelected, how to proceed in the formation.

I. In all native ſoils, where vegetable earth abounds on the ſurface, and where there are not conſiderable

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impediments to the uſe of the plough; there, ſuch is the moſt uſeful tool applicable to form the ſame at moderate expence.

II. Where much of the ſurface is compoſed of vegetable earth, there, ſuch ſhould be taken away completely, prior to the application of materials; its tendency to abſorbency, and its ſpecific gravity, rendering it leſs proper for a baſe than is any compoſition of the native earths of ſand, lime, or even of clay, each of which are progreſſively uſeful as claſſed.

The road, when formed, ſhould be ploughed as nearly to the form preſcribed as convenient, and levelled to the ſame by ſhovels, hacks, &c. Care being taken that each ſide of the road have preciſely equal deſcent from the centre, and in no caſe varying, as is often done in the deſcent of hills, &c.

On the Covering neceſſary for Roads.

I. THE materials requiſite and moſt readily acquirable, are uſeful in proportion to the rules aſſigned, always recommending the application of the beſt, and they ſhould be univerſally broken into pieces of, or nearly of the ſizes noted.

Theſe materials, thus broken, ſhould then be uniformly ſpread over the ſurface of the road, and the depth requiſite will probably in no caſe be more than from nine to twelve inches in thickneſs; in roads not

not much oppreſſed, ſeven inches are ſufficient. Stones ſhould be left ready broken near the ſides of the road, to ſupply all the diſplaced materials, which the carriages rolling thereon either bury or derange, as ſuch derangement will inevitably occur, until the road become ſpecifically equally adheſive throughout its breadth; and the preſſure on the ſummit, being the part where the carriages moſtly go, will require greater proportions of materials to be there applied.—This addition will likewiſe remedy the greater depreſſion, that, in the earlier ſtage, will of neceſſity take place near the centre, from the more conſtant friction occaſioned by the general preſſure applied there.

N. B. In all new-formed roads, particular care ought to be taken that the ruts or inequalities ſhould be levelled or filled up, nearly as ſoon as formed, as until the baſe of the road is cloſely conſolidated by preſſure, all moiſture can with conſiderable facility, ſink therein, and when it has ſo done, it occaſions the road to ſhrink around every part, where ſuch admiſſion has taken place. Where the line is formed through a rock, there ſuch rock ſhould ever be excavated ſufficiently to give place to materials ſimilar to thoſe applied elſewhere along the line, thus inducing equality of duration.

Water Courſes, Drains, &c.

STRICT regard muſt in every inſtance be paid to the equally curving inclination of the ſides from the centre

centre, and to the formation of water courſes at ſuch ſides. The water thus dividing equally, does equal damage to each, and the carriages rolling with equal facility on either ſide, occaſions a regularity in the wear, otherwiſe unattainable; yet it will here be requiſite to remark, that in roads along deſcending hills, a departure from the general rule of elevation is requiſite, as many deſcents decline more rapidly, than its ratio allows, and in ſuch caſes, the elevation of the road, muſt, in a ſlight degree be more conſiderable, than the abſolute deſcent of the hill; thus giving to the rain, dews, &c. an eaſier road to the ſides than the hill itſelf would allow, down whoſe deſcent it would otherwiſe diſcharge itſelf, in place of gaining the ſooneſt poſſible, thoſe open drains formed on the ſides for its quittance. Where hills are of conſiderable length, underground drains, flagged at the bottom, ſhould be made to take of the water wherever wanted, and thence throw the ſame to the under-ſide of ſuch road and into the adjoining ground, thus guarding from its otherwiſe inevitable damage.

Rules for the variation in the rise of the centre of the roads, where such roads run along the descent of hills, &c.

WHERE, from the centre downwards in a direct line, the road falls or dips two inches in the yard, to prevent the water floating down ſuch deſcent, which occaſions conſiderable damage there. From ſuch centre

tre, on roads of two inches direct deſcent, the ſide deſcent ſhould dip two inches and one third per yard; where three inches direct, three inches and one third ſideways; where four inches, four inches and one third, attending to ſuch ratio as a general rule of deviation from the original one laid down, and thereby guarding againſt that waſteful wreck of materials, which generally takes place on the ſides of hills, after any ſeries of moiſt weather, and which can alone be remedied by the variation in deſcent, being made more conſiderable from the centre to the ſides, than it is directly down the hill or line of the road; thus quitting the whole water in the ſhorteſt poſſible courſe, from the ſurface into the ſide drains, and which drains or water courſes ſhould at all times be ſtrictly attended to, and kept free from every ſpecies of obſtruction, both when laid athwart and along ſide of every road. The deſcent when greater than four inches, is not attended to, as ſuch, in all places, ſhould be changed by art, into a deſcent not exceeding ſuch ratio, or a ſmaller one.

Watering Places on the Roads, &c.

THE utility of watering places, both where running ſtreams occur (and where reſervoirs can be made uſeful) near to the ſides of roads, and more particularly near to towns and villages, are unanimouſly acknowledged, and in ſo variegated a country as England

England, it rarely happens that any conſiderable diſtance intervenes, where the power of diverting the current of ſome ſpring or rivulet is not acquirable, in ſuch manner as to obtain the wiſhed for object.

Where ſuch places are attainable, as they may be generally by means of pipes, or by taking advantage of the deſcending ground, filling up and puddling ſuch deſcending ground, ſo as to acquire the elevation of thirty to thirty-three inches for the water at each wiſhed for ſituation; and where, except the expence ſhould prove very conſiderable indeed, ſuch watering places (and the beſt are thoſe of hollowed ſtones) ſhould be made. The raiſing them to the propoſed height, gives conſiderable eaſe to the horſe, and to all animals in drinking thereat; in froſts they are not liable to ſlip and fall, nor in drinking when heated ſo liable to ſuffer from the water, as when obliged to draw up the liquid in conſiderable draughts, and conſequently to throw the ſame with greater burthen on the cheſt; to which cauſe, in the horſe, *broken windedneſs* may often be imputed. Where convenience admits, thoſe wells or troughs ſhould ever be made from nine to ten feet and a half long, ſo as to allow a team of four horſes to drink at the ſame time. The water ſhould be admitted and let out at the back part of the ſame troughs, thus guarding againſt the damage from ſuperfluous moiſture, and from the effects of froſt. The road in front ſhould be ever kept in

in a perfectly good ſtate, and rather riſing than deſcending to the water, with good guards of wood or ſtone to protect the trough from accidental damages, which might ariſe from inattention; and the drain to carry off the water ſhould never be neglected, ſo as to let any reſt on or near the watering place.

Mile-Stones, Guide-Posts, &c.

THE diſtance in miles being ever fixed on Turnpike Roads, it would be adviſable ſo to form the mile-ſtones, as to make them anſwer the additional purpoſe of a horſing clog, where to alight at, or mount from, which would prove of conſiderable utility to the fair ſex; where conſiderable bye-roads interſect, ſo as to perplex the principal one, guide-poſts ſhould ever be erected. The law gives a power to enforce their application, and the magiſtrate is eſſentially uſeful who puts that law into execution.

Private Drains on the Sides of Roads, &c.

IT is an object of much conſequence to prevent the drains from any higher land, from being allowed to run on the borders of a public road. They ſhould ever be within the adjoining grounds, and the individuals, for whoſe benefit they are made, ought to be obliged as the law directs, to keep their courſe clean, ſo as to prevent any probability of their doing injury to the high road.

REGARDING

REGARDING HEDGES, &c.

IT is of material conſequence, that the hedges on the ſides of roads ſhould be kept moderately low; the general law gives ſufficient power to the ſurveyors, yet its exertion would be rarely called for, were the neceſſary cautions attended to, which point out the keeping a road of equal height on both ſides, and thoſe ſides declining equally from the centre, the drains thereof conſtantly open and free from any object to impede the courſe of the water, whether occaſioned by ſprings, or by falls of rain, ſnow, &c. It may be of uſe to add, that all hedges ſhould be ſo formed, as to reſemble an egg ſet up on the broad or thick end, for in this caſe, the branches partaking equally of the rain and dews, are kept in an equable ſtate of health.—Their baſe need in no caſe to exceed thirty inches, and their aſcent ought to be curved in ſimilar proportion to that of a hen's egg, the top twelve to fourteen inches.

On Hammers used for Stones, &c.

IN the different parts of England, for the breakage of ſtones, hammers of a variety of conſtructions are uſed, and thoſe variouſly fixed, in which fixture a trifling difference makes a conſiderable one as to utility; we ſhould recommend the form of an egg as moſt likely to prove generally uſeful; it is more eaſily lifted, and ſtruck down with greater facility, than any other general

neral form, the weights are moſt frequently made too heavy, for the uſefully breaking ſtone into ſmall particles, and in many roads much labour is loſt for want of what is called, in Yorkſhire, a kibbling hammer, or one of intermediate ſize from the larger ſpecies, uſed to break ſtones of conſiderable bulk into medium ſizes, when the ſmall hammer acts on them with greater facility; the ſhaft ſhould not be too thick near the head, and generally made oval, for the reaſon aſſigned reſpecting the head. The author would likewiſe recommend an iron rake, with rounded teeth, and thoſe of moderate length, firmly fixed, as the moſt proper inſtrument wherewith the workman can moſt eaſily form his roads to the intended plan, or with which he can moſt readily level his materials when properly broken.

On the Levels of Roads.

THE judgement which the eye can form reſpecting the equal heights of the ſides of roads, being liable to conſiderable deception, the uſe of the ſpirit level is recommended generally wherewith to try the ſame; that alone can tell with preciſion, and a frequent uſe thereof will aſſiſt the eye in forming a judgement.

Horſe and Foot Cauſeways.

IN the formation of all horſe or foot cauſeways, or indeed in the laying of all flags or pavement, the beſt

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can eaſily be laid aſide, then to lead or wheel the baſe off, until you have lowered the ſame to the deſired line; in other caſes where materials are wanted to raiſe the deſcending part of the road, for the purpoſe of equalizing the deſcent, it may prove more uſeful to take the ſtrata ariſing from under ſuch ſurface, and with it raiſe the lower or deſcending part of the hill, till you obtain the regular and equal acclivity of one inch and a half per yard, from the baſe to the ſummit, if eaſily acquirable, or if not, ſuch ratio as may be found moſt uſeful, combining utility and expence. Varying ratios may at times be adopted with advantage, but that of one inch and a half is moſt deſirable, where the funds of the road will allow the expenditure, and its acquirement ſhould be ever an object in view, and ought to be undertaken where uſeful by the truſtees.

The firſt expenditure once made, the repairs are ever conſiderably leſs than their coſt had been preceding the operation, which by leſſening the friction in deſcending, and ſparing the application of force in the aſcent, requires much ſmaller portions of materials to ſupply the waſte on the ſurface; the duration of which is ever in proportion to the weight rolling on, and the force applied to move ſuch weight.—Where the road was in moderate ſtate prior to the intended improvement, the materials will generally ſupply the ſame line after the under ſtrata have been formed to the intended regularly inclined convex plane. *Of*

Of Covered Conveyances for Water Courses, Small Rivulets, &c.

IT frequently happens that roads are interſected by the courſe of trifling brooks, which, in proceſs of time, make an aukward and not unfrequently a dangerous hollow in the paſſage over them; in froſt they are ever particularly dangerous.—The expence attending the making a bridge over, is generally ſuch as prevents the undertaking, and, where it is done, from the improper curve uſually adopted, approaching nearly to a ſemi-circle, conſiderable inconvenience is occaſioned by the hill made on each ſide of the ſame, which would not have place, were the form adopted that of an extended elliptical curve. This curve ſhould be generally adopted where the funds will admit it; where not, a much cheaper mode may ſupply the deficiency, which is that of making, as occaſion requires, two or more upright walls, and upon them, laying rough long ſtones, capable of bearing the weight of carriages. Thoſe ſtones ſhould be covered firſt by a pretty thick layer of earth, and then by the ſame materials uſed generally for the road, which will prevent any damage to the bridge or water courſe, and its breadth ſhould ever be equal to, or exceed that of the road, to prevent any inconvenience from carriages which might meet thereon; ſuch, likewiſe ſhould be the plan purſued in making all bridges over ſmall rivulets; and the beſt battlement is a living

living fence planted in a line with the adjoining hedge-rows, to whoſe boundary the arch of the bridge ſhould ever be carried; and if ſubject to ſudden floods or rapid riſes of the current, there ſhould ever be ſpare arches to receive the ſuper-abundance at ſuch periods; by this means guarding againſt the danger of the bridge being ſwept away.

N. B. Rills generally deſcend near where bridges are neceſſary, and by that means afford convenient opportunities to make watering places.

On Pavements for Roads.

PAVING, though a durable mode of road-making, yet occaſions ſo conſiderable an expence in the repairs of carriages, and the comparative damage to horſes, that the author deems it, for a turnpike-road, a much more expenſive mode of public accommodation, than that of roads formed by the union and combination of ſmall particles, agreeable to the principles laid down.—When the materials are of good quality, completely broken, and aſſimilated with the intermixture of ſmall ſand, gravel, or whatever may fill each vacancy, the adheſion becomes ſo firm, as nearly to reſemble ſolid ſtone.

Such roads poſſeſs this ſuperior advantage, that when any part becomes concave, then freſh materials in a moderately moiſt atmoſphere; or when dry, aided by

by the application of water, combine readily with the old materials, and become equally firm after a ſhort uſe of carriages upon them.

Thoſe vacancies ſhould be filled at all times rather higher than the level, to allow for the requiſite compreſſion, to make them equally ſolid as the road which has been long uſed. And the intermixture of ſand, &c. upon the ſurface, after the ſtones are laid on, or the application of other matters not likely ſoon to decompoſe in the atmoſphere, by filling up the interſtices, prevents the admiſſion of water, and accelerates the acquirement of proper denſity.

Drains on the Sides of Hills.

OBSERVATION will indicate to every traveller in winter time, the extraordinary quantity of moiſture generally perceptible in ſoft weather on the ſides of hills, where common opinion ſuppoſes none to pervade. This cauſe injures the road in innumerable inſtances, and its ſource originates in the alternate ſtrata of the internal ſoil, whoſe interſtices admit the percolation of water, and whoſe dip or inclination varying in its deſcent from that of the road, admits the water at the end or loweſt dip of ſuch ſtrata, to break out on the ſurface of ſuch road, where, unleſs carried off by art, this extra moiſture ſoftening all the materials around, too frequently occaſions a quagmire, or near approach thereto.—As a guard againſt this evil, in all aſcending ground where moiſture is at any

any time too abundant, there, interſecting and nearly horizontal drains, about a yard deep, ſhould be made acroſs ſuch hill, and the water thus intercepted, may with eaſe be conveyed down the dip; and at the ſides of ſuch hills without ever incroaching on the road ſo as to be detrimental.—The expence thus incurred will eventually prove a conſiderable ſaving, and many aſcents bad at all times in damp weather, may be thus kept durably good, and with leſs annual expence.

N. B. Although the oozings or drips of water often occur in the deſcent of a hill, it frequently happens, that a drain intercepting the uppermoſt, may prove a permanent cure, as the others are often only deſcending outlets from the ſame ſource.

On the Combination of Draining, with the best Mode of Road-Making.

AS the local ſituation requiſite for the baſe of roads, continues in progreſſive lines, and thoſe of different ſtrata, where the baſe varies conſiderably in its compoſition, it may not be amiſs to remark, that where opportunities of choice occur, the beſt is to fix on ſuch where the principal ſub-ſoil is compoſed of ſilicious materials; the next that of the harder ſpecies of limeſtone, each of thoſe being generally moſt free from admixture of argillaceous matter, and that, the worſt baſe of all is that where the general compoſition is clay, or poſſeſſing that material in conſiderable proportion.

The

The abſolute cauſe of difference in their varying qualities, ariſes from a ſource, as yet but ſlightly attended to, in this particular inſtance of road-making. Yet in effect, one which probably occaſions the greateſt injury to roads; this cauſe is water, which by its union, occaſions conſiderable miſchief, and the period when the injury is ſuſtained, in the moſt conſiderable degree, is that when the ſeaſons change alternately from froſt to thaw.

The ſpecific gravity of ſtones uſed for roads, varies from 2,500 to 2,800; admitting the medium as their general weight, or 2,650, we may then calculate their capacity of ſaturation, in proportion to their native compoſitions, agreeable to the laws which regulate ſuch ſaturation, obſerving, that it is probable, when in their compoſite ſtate, ſuch laws can only partially affect them, and that the principal detriment ariſes from the proportion of ſuch original ſtones, ground by attrition into particles nearly ſimilar to thoſe of common ſoils, in which caſe moiſture and froſt have each full effect thereon.

Stones compoſed of pure ſand, when reduced ſmall, may ſwell in bulk, if fully ſaturated, from one to one inch and two-thirds.—Stones of calcareous quality, as marble, hard lime-ſtone, &c. if pure, from one to two inches and one-third.—Stones, or that part of their original compoſition which conſiſted of clay, from one to five inches and one-ſixth. It

It is probable that ſuch ſaturation has never had place, except by the intervention of art, yet it is equally ſo, that the half of ſuch ſaturation may not unfrequently occur, when the bulk will be proportionably enlarged. The materials, then incapable of their former reſiſtance, and acted on by objects invariably the ſame, are ſoon ground when ſoftened, (if uſed in conſiderable degree in damp weather,) into one maſs of puddle, as the ſun poſſeſſes little power to forward evaporation.

It is, elſewhere, when ſpeaking of materials uſeful for roads, ſtated, that the purely ſilicious ſoil abſorbs only to the extent of twenty-five per cent.; the pure calcareous to that of fifty per cent. whilſt the capacity of abſorption of the argillaceous, is equal to two hundred and fifty per cent. or two and a half times its own weight; hence as the effect of froſt is to ſwell up or extend the bulk of all water whereon it acts, in the ratio of eight to nine, for ſuch reaſon, its effect on ſilicious matter completely ſaturated, extends in the proportion of two parts in five of its whole bulk, including the abſorbed water. This is on ſuppoſition, that on the mere earth, the froſt has no effect, and its power confined to exertion on the water only, which is combined in the compoſition. The effect on pure calcareous matter, extends to the ratio of four-ſevenths of its bulk on the ſame ſuppoſition; whilſt on clay, the extenſion ariſes ſo high as twenty-five parts in thirty-one of its relative bulk; and in conſequence of

thoſe varying qualities of abſorbency, and the intimate union of water with the peculiar ſoils.—In ſuch degree it is, that froſt diſunites or decompoſes the varying proportions of materials uſed for roads, and in ſimilar ratio all the baſes of roads, on which the materials are not put in a proportion, ſufficiently thick, to guard the under-ſtrata completely from the effect of froſt thereon, and to which ratio ſuch covering is very rarely extended, on account of the ſurplus expence ſuch an extraordinary quantity would induce. Hence, it is obſervable, that immediately after a ſmart froſt, and ſo ſoon as the variation of the atmoſphere has penetrated ſufficiently deep to thaw the baſe of any particular road, whoſe compoſition is in a conſiderable degree argillaceous, there, ſuch baſe becomes, on account of its tumefied ſtate, inadequate to ſuſtain thoſe weights, which its prior local denſity poſſeſſed the capacity of doing; and that in ſuch caſe, the ſurface road yields unequally, and becomes full of ruts and quagmires, amendable only by the application of a covering adequate to protect the now expoſed baſe from ſimilar expoſure, or by awaiting the ſlow progreſſional change of ſeaſons, which (in their courſe attracting the ſurplus water combined with the ſoil) give the requiſite firmneſs and capacity for reſiſtance.

It is true that moſt ſoils acquire this firmneſs during the progreſſion of ſummer, although, when unaided by art, they are left equally liable, from the alternacy of

of change, to ſimilar evils as were before experienced, and ſuch evils are haſtened in a variety of inſtances on roads of every varying ſoil, by their being ſo planned, as to have ſprings breaking forth in their higher ſides, or frequently in the direct line they run, which caſe often occurs in the aſcent or deſcent of moſt hills, as it is in ſuch ſituations that Providence has ordained the change of air into water to have place, and where, from ſuch change, the obſtructed currents of the wind diſſolve and flow off in percolating ſprings to ſpread fertility on all below.

Were it not that man poſſeſſes a general power to remove the evil, ſuch injuries would ariſe from this cauſe as would be difficult to overcome; but, here the remedy applicable is not of difficult acquirement, and conſiſts ſolely in the application of a drain or drains acroſs the part of the hill, placed in ſuch poſition, as to arreſt or ſtop the whole of the deſcending water, and then by a deſcending downright vent, to be ſo diverted in its current, as nevermore to flow on, or interſect the ſame road.

Similar advantages are acquirable in a conſiderable degree, even in roads of clayey baſes, by the ſame medium, and although the appearance of immediate expence might deter many from attempting the remedy, yet it appears, from a variety of experiments made on different roads, that ſuch original expence is amply compenſated

compenſated by the greater ſecurity it affords to the baſe on which the materials reſt, and which, in conſequence of being thus leſs affected by the influence of froſt thereon, or even from the buoyancy, which ſimple abſorbency occaſions, ſpares conſiderable ſums in the general repair, guarding equally againſt the tumefaction of the ſub-ſoil, and preventing the introduction of that ſurplus proportion of water, which would alike ſaturate both the ſoil and the materials, whereof the road itſelf was compoſed.

On the Roads near to London, or to any considerable Place, and the reason why they would be more useful if made into two distinct Roads, when of great Breadth.

THE principles laid down in the preceding treatiſe, induce the author to ſuppoſe that public accommodation would be attained, near to London, or any extremely buſy town, in a much greater degree, and at leſs annual expence, by making a diviſion of the preſent roads into two, obliging all travellers to uſe them when ſo formed alternately, as going or returning roads. The reaſons to be adduced are, that the ſegment of a circle neceſſary for roads wider than thirty-ſix feet, (which requires twelve inches of elevation as proper for quitting the water readily) curves with too much rapidity for carriages to roll eaſily thereon, and that even at that breadth, the ſides have rather

too

too much of deſcent; whereas ſuppoſing a road to be fifty feet wide, requiring a curve of ——.

Two roads of 24 feet each, may be made in the ſame breadth, with the eaſy curve of five inches and a half, and leave a ſpace in the centre to take off the water from each, which may be eaſily quitted by drains to either ſide. The facility of conveyance would be greater in conſequence of the form, as well as from not being liable to obſtructions, from the meeting of any paſſengers or carriages. Each road would admit of two carriages with eaſe, and of three carriages to paſs where abſolutely neceſſary, as alſo of a horſeman at the ſame time. The repairs would be conſiderably leſs from the ſmaller quantity of friction, and the greater facility with which water would be quitted on the roads thus formed, as the carriages would then be enabled to run on a ſurface with equal, or nearly equal preſſure from each wheel, and not be liable to be turned out of their courſe as at preſent.—In wet weather the roads near to London are in a ſtate of paſte, and in dry weather when unwatered, in that of a conſtant cloud of duſt; thoſe inconveniences would, in the plan propoſed, be generally prevented, and at a conſiderable leſs expence, than the repairs of the roads coſt in their preſent ſtate; which improvement would be alſo conſiderably accelerated by the adoption of waſhing the materials in ſuch manner, as to quit the clayey matter prior to its being conveyed to the road.

ON

ON CONCAVE ROADS.

UPON this form the writer would not have made a comment had he not ſeen a recommendation thereof by ſome, to whoſe judgement, he, in other caſes, ſhould pay deference.—The general laws of nature affecting all ſoils and all ſubſtances equally, and this particular form occaſioning the admiſſion of more conſiderable quantities of water thereon; either his ideas of the ſource from whence injuries ariſe to roads muſt be ill founded, or thoſe who form roads on this principle, err moſt egregiouſly in adopting the concave in place of the convex form, as the one places the materials in a ſituation of abſorbency, the other in one of quitting moiſture. The only deducible advantage from this local form, is that as clayey materials are readily ſoluble in water, ſuch may thus be floated off, yet the damage occaſioned by the ſame water intermixing with, and its conſequent tendency to diſſolve and ſeparate the other materials, muſt much overbalance any poſſible acquirable advantage.

Errors in old formed Roads.

AS errors have been committed in the formation of the exiſting roads, many of which may with eaſe be rectified, to point them out, and the eaſieſt mode of remedy, may probably prove an uſeful leſſon, when attached to that of fixing the beſt rules for forming and making new ones.

LARGE

LARGE STONES laid as FOUNDATIONS.

WHEN turnpike-roads were firſt introduced, the opinion prevalent was, that no road could prove durable, where the under-layer or ground work was not compoſed of large ſtones, whoſe ſolidity would ſupport the materials laid thereon, as well as the weights of heavy carriages. This primary miſtake induced a heavy expence, and entailed its continuance on every road formed upon ſuch principle, as, in conſequence thereof, the under-ſtrata not being completely ſolid, the preſſure of any heavy body on the ſurface, occaſions the depreſſion of part of its materials into thoſe vacancies, and admits therewith, the introduction of water from this diſequalized ſurface, into ſuch ſituations as prevents the effect of the ſun or wind thereon. Whence its permanent action ſaturates, and renders every particle around, when ſo ſaturated, incapable of ſuſtaining the former burthen, and, in moiſt weather, occaſions the whole to become ſoft and greaſy.

REMEDY.

THE only ſecure one is to have the whole completely dug up, and all the larger materials broken into ſmall pieces, none of which ſhould exceed the ſize of a ſmall hen's egg, in which ſtate the whole can uniformly adhere, and thus prevent the admiſſion of water.

Large

Large Stones irregularly mixed with those of smaller size.

LARGE Stones intermixed with ſmaller ones, or thoſe of proper ſize, are found in many roads, particularly in thoſe formed of gravel, where inattention too frequently leaves ſuch unbroken. Materials ſo intermixed can never cement firmly, and the ſolidity of the larger ſtones reſiſting the preſſure from carriages is the ſource of continual obſtructions, and of additional fatigue to the horſes, whoſe exerted force having overcome the obſtruction, occaſions the carriage to deſcend with added force and increaſed velocity, thus cauſing inequalities in the ſurface and cavities in which the water reſts and ſpoils the road around.—The damage to the carriages, and the danger occaſioned thereby to riding horſes, are conſiderable, even were we to overlook the ſerious evils which the riders often ſuſtain.

Remedy.—The only one is ſimilar to the preceding, and admits no other medium of cure.

Inequalities of Height in the different Sides of Roads.

SUCH frequently occur from want of plan or inattention, and hence two cauſes unite to injure roads ſo formed.—The preſſure of the carriage is inevitably unequal, the heavier weight always reſting on the lower

lower ſide, whence ſuch ſide decays or wears faſter than the higher one, and hence is the ſource of thoſe inequalities. The ſecond is that whenever rain falls; its particles deſcend and are detained in thoſe inequalities, in whoſe cavities it lodges, and the preſſure of carriages combines the ſame too frequently with the materials.

Remedy.—The beſt is generally to lower the upper-ſide, if not, add freſh materials to the loweſt ſide to equalize the elevation.

Hollowness or Concavity in the Centre; its impropriety and detriment.

NOT unfrequent, particularly in contracted road, is the error here noted, and frequently in the deſcent of hills, originating in the miſtaken idea, that whenever time or force of water has worn much of the road away, ſuch waſte can alone be ſupplied by new materials, which are then laid on the centre, without adverting to the ſides; the lowering whereof would be the only proper mode to remedy the evil, and which, if not attended to, proves the inutility of laying on materials in ſo injudicious a manner, as the firſt heavy rain thus confined to the centre, in its deſcent, ſaturates the materials in conſiderable degree, and ſucceeding ones enhance the evil to ſuch degree, that the materials ſoftened to a paſte, reſiſt only till the added force of one heavy ſhower ſweeps off the whole, and probably with increaſed injury. *Remedy*

Remedy.---The beſt attainable one, is the forming the road convex, and allowing a more conſiderable deſcent from the centre to the ſides, than is that of the dip of the hill. *For rules applicable ſee page 24, &c.*

Obſtructions raised on the Surface to throw off Water.

OF all the crude inventions for the amendment of roads, this is one of the moſt abſurd, its form occaſioning additional obſtructions to thoſe the hill itſelf preſents, both for carriages and horſes.

Remedy.—Wherever ſituations render it neceſſary to quit the water from the higher to the lower ſide of the road, there, drains underground, and thoſe flagged or paved, ſhould be the medium, and their deſcent ſhould be at leaſt, equal to that which brought the water to them, elſe the materials would ſoon obſtruct the paſſage.

Water Courses and Springs.

WHERE roads have thoſe on the upper ſide thereof, there art ſhould as ſoon as poſſible, be applied to divert the current to the lower one, thus preventing the ſaturation of the materials, which ever has place when the water preſſes thereon, as in ſuch ſuppoſed caſe it muſt, attention ſhould be paid to the prevention of ſuch moiſture from ever getting again on the road.

N. B. This

N. B. This ſame rule applies equally to ſprings on the higher ſides, if, or internally on the road, as unleſs ſuch are kept from having effect thereon, no art can keep the under ſtrata dry and firm.

Materials on the Sides of Roads, why not to be left.

MATERIALS ſhould be laid in receſſes, and the breakage thereof in conſiderable bulk, ſpares much of labour, as ſcarce a blow is then waſted. Their being left unbroken, occaſions a variety of unfortunate accidents, and from neglect they are often laid ſo careleſsly on the ſides of roads, as to obſtruct the deſcent of water, and even to turn its current on the road, whence ſerious damages are occaſioned.

WATERING PLACES.

THAT places for the convenience of watering cattle on the ſides of roads, or elſewhere, are extremely uſeful, few, perhaps none will deny; yet a conſtant error ſeems to have prevailed in the formation of thoſe moſt uſeful objects, and the parched beaſt may have often had reaſon to curſe the blinded ingenuity of their founders. That cattle may drink at eaſe, the height of the water ſhould ever be that of a horſe's ſhoulder blade, and may be averaged at about thirty-three inches; it rarely happens but that any ſpring (moſt of them having their ſource in hilly ground) may

may be ſo conducted at a ſlight expence, as to fill a trough or reſervoir made that height.---To give water at the ſame time to a team of four horſes, the trough ſhould be three yards to three yards and a half long, its depth ſhould depend upon the ſupply of water, and the expence would never be conſiderable when compared with its utility, as hollowed ſtone, the beſt material, is ſeldom very dear. It is neceſſary to remark that the water ſhould ever be admitted on the back ſide of the trough, and have its outlet on the ſame ſide. By this means the inconvenience of water ſpreading on the road is prevented, and its conveyance ought ever to be into an underground drain, which ſhould quit it for ever from the road.

On the Streets and Foot Paths in and around London.

THE obſerver accuſtomed to weigh the advantage attainable from a proper application of art in the formation of roads, will diſcover conſiderable defects in the general form of moſt of the ſtreets and cauſeways in the City of London, where, although in ſome, there is a near approach to perfection, yet, it is ſo rare, that it gives proof how little ſcience has been conſulted in the formation, and that to accident or nearly ſo, the forms approaching to real uſe are indebted.

One

One glaring defect is general, in a conſiderable number of the leſs frequented ſtreets, and even in ſome of thoſe conſiderably in uſe, which is a continuance of the ancient mode of permitting the water or kennel to flow down the centre, in place of the ſides.---The conſequence whereof is a continual diſperſion of the water mixed with dirt over the whole ſurface, as the neceſſary pathway of the horſe is confined to ſuch contracted ſpace ; and a yet greater injury ariſes from the diſplacement of the ſtones in ſuch kennel, by the leſs powerful reſiſtance their baſe is capable of affording, from being continually in a ſtate of moiſture.

Another defect, though in a degree leſs injurious, is more conſiderably extended in all the better formed ſtreets, where, although the water is not permitted to flow along the centre, yet the diſtance from the kirb-ſtone, is, for ſome unknown cauſe, made ſo conſiderable, as to loſe, in moſt of the wider ſtreets, the ſpace of from twelve to eighteen inches on each ſide, or on the average nearly one yard in the width of the ſtreet. The proper application of this now uſeleſs ſpace would add ſo conſiderably to the general breadth, as to give encreaſed convenience to the paſſage of all carriages, and in many inſtances, capacity ſufficient for an added carriage to roll thereon ; in moſt it would prevent the ſplaſhing incident to the preſent form, where neceſſity too frequently compels the dray and other carriages to paſs with their wheels

wheels along the kennel, incommoding the foot paſſenger extremely, and by their preſſure, diſplacing each ſtone within their courſe; where the baſe is thus made moiſt by water, thereby loſing its equality of reſiſtance to the compreſſing power, and ſuſtaining a detriment which occaſions an extraordinary expence for its repair, that ought to be avoided.

The rules requiſite for the elevation of paved roads vary from that of a turnpike, as the greater facility of quitting water, in conſequence of the leſs number of impediments, allows a nearer approach to a plane, and a breadth of road of thirty-ſix feet, requires only the elevation of eight inches, in place of twelve, which is requiſite in the former, the elevation of narrower breadths are noted in their proper gradations.

The proper mode of quitting moiſture in all large and populous places, is beſt attained by conveying the ſame, the ſooneſt poſſible, into underground drains, or common ſewers, where convenience admits ſuch uſeful mediums, where not, the evil muſt be ſubmitted to. But as few ſituations allow not the opportunity either on the ſides or the centre, ſuch convenience ſhould, if poſſible, be attained, and along the ſides of the kirb-ſtones, grates ſhould, about every twenty or twenty-five yards, admit a paſſage from the ſurface to the internal conveyance. Thoſe underground drains ſhould be ſo conſtructed, as to leave

leave a paſſage ſufficiently large to admit a perſon to clean them when obſtructed, without uncovering the ſurface, and their baſe ſhould be an inclined plane, and that flagged, elſe, in any deſcent where much of water flowed, the current would diſplace the ſides and ſoon ruin the conſtruction.

The formation of the kennel ſhould be laid by a ſingle ſtone, riſing ſlowly to the apparent baſe of the kirb-ſtone, another ſingle one laid flat ſhould be the centre of the kennel, and from its edge, the elevation of the ſtreet ſhould gradually riſe to its appropriate centre; and in aſcent ſimilar to that of the ſcale laid down for pavements; excepting the local deſcent of hills, where the line of elevation ſhould vary, agreeable to the abſolute deſcent of the hill, and from the centre to the ſide, allow a deſcent in a ſlight degree more conſiderable, than is that of the natural or artificial downright deſcending line of the ground. This additional deſcent it is requiſite to obtain for the reaſons aſſigned, where turnpike roads are treated of.

EXAMPLES of ERRORS.

AS evils are beſt ſeen by example, the errors treated of in the preceding notes, are obſervable in conſiderable degree, in one of the moſt frequented ſtreets in London, viz. from St. Paul's to Fleet Market, where

where, during a rainy day, the inconvenient ſituation of the kennel, is ſeen in a ſtrong point of view, as down a deſcent, ſuch as that is, the water, in its paſſage frequently overflows the particular line wherein it ought to be confined, and the reſulting conſequence is the diſplacement of the ſtones for nearly half a yard on each ſide of its current. The kennel on each ſide next the London Coffee-Houſe, as alſo that oppoſite, is placed at the leaſt, twelve inches too far from the kirb-ſtone of the foot-way, and conſequently deprives the pavement of that additional breadth, which properly applied, would, when taken from each kennel, and added to the already extra ſpace for two carriages, allow ſufficiency of breadth for a third to roll with facility thereon. The elevation of the pavement, ſeems on inſpection, too conſiderable for the preſent breadth, and as far as the eye can judge, is even greater than the propoſed extenſion would require, when the ſpace added by the change propoſed ſhould take place, which addition, by carrying the channel for the water near to the kirb, would thus allow the convenience ſtated, and thereby guard againſt the ſplaſhing of carriages, which ſo frequently incommodes the foot paſſenger, and alſo prove a prevention to the damage incident to all roads kept generally in a moiſt ſtate.

Thames-Street and moſt of the narrow ones might be conſiderably amended, by attention to place the kennel properly.

Equal

Equal errors and thoſe important ones have alſo place in moſt of the foot cauſeways in London, and which ſeem alſo to have their original ſource in the neglect of ſcientific rule, or the want thereof.

The firſt principle on which all cauſeways, or indeed all roads ſhould be formed. is, to equalize the denſity of the baſe, by having the ſame beaten or compreſſed in the firſt ſtage, with a heavy rammer or roller, until brought to ſuch equalized ſtate. Then in cauſeways the ſame ſhould be covered with ſand, ſmall gravel, or aſhes, ſufficient to allow place to equalize the ſurface; the flags uſed frequently varying in degrees of thickneſs, an object of conſiderable importance to attend to, and this regulated attention at the firſt, prevents that inequality of depreſſion, which elſe aſſuredly takes place, and by letting water reſt partially, brings on premature decay.

The elevation moſt uſeful for flagged footways, is that of $\frac{1}{8}$ths to $\frac{5}{8}$ths of an inch per yard, gradually from the kirb-ſtone, which ſhould be rather more depreſſed proportionally as leſs liable to be worn by uſe.

This rule attended to, gives eaſe to the foot, occaſions leſs wear of the ſhoe, and conſequently prolongs the duration of the path, as ſubject to leſs of friction than any other varied form.

EXAMPLE of ERROR.

THE new-built ſide weſt of Temple Bar, the preſent month of November, 1804, exhibits in the newly laid foot cauſeway, a complete ſpecimen of inattention to rule or to convenience; no attentive paſſenger can go over the ſame without feeling the inconvenient mode in which his feet are obliged to place themſelves, and ſuch inconvenience, will, with increaſed rapidity, deſtroy the ſurface; but were it poſſible to calculate the increaſed deſtruction of ſhoes thereon, the expence would, if proveable, ſurpaſs every idea of calculation, and enhance the private expenditure in a ten times tenfold proportion.

Private expenditure, when increaſed more than neceſſary, is generally public loſs. The diminution of ſuch expence, before unavoidable, is ever a public good.—Hence, whenever the funds of a community admit the poſſibility of general ſaving by public expenditure, and to which all muſt equally contribute, that ſaving, if exceeding intereſt, is public gain.—What I wiſh here to inſiſt on as eventually a conſiderable ſaving, is the introduction of flagged cauſeways in place of the gravel foot-paths ſo general around London.—The intereſt of their principle would to the public at large, be trebly ſpared in the ſaving of ſhoe-leather.—The change would accelerate the facility of walking, and much of the dirt reſting on the gravel

walk

walk, would not accumulate; were the ſame converted into a path properly and ſcientifically laid, with well-grained flags; might this remark introduce the change, ſuch alteration would amply recompenſe the author for attention to this uſeful object.—Yet it is requiſite again to repeat the neceſſity of attention to the rule of deſcent and the firmneſs of baſe, &c.

FUTURE IMPROVEMENTS.

THERE remains yet conſiderable improvements to be made in many of the ſtreets, and attention might have conſiderably amended the line adopted at Snow-hill.

IN all variations the rule ſhould be to, have exact dimenſions taken from the loweſt point to the higheſt of any intended variation, and then after obſerving the height capable of being taken from the ſummit, ſo as not to prove injurious, and the elevation, which may with propriety be given to the loweſt part, then to calculate the remaining ſpace by its length, and divide the elevation by an equal ſcale of gradation.—The hollow at the foot of Snowhill, might have been conſiderably raiſed without inconvenience, thereby changing the preſent plan, and facilitating conſiderably, the aſcent to the city; and alſo into Holborn, the aſcent to which, by attention to the preſent rule, may at very moderate expence, be conſiderably improved,

proved, as might that of a conſiderable number of the ſtreets in London and Weſtminſter, (particularly near Charing-Croſs) were attention duly paid thereto.

This mode of application alſo proves a conſiderable eventual ſaving, conſequent on the diminution of friction which regular inclined planes ſuſtain, compared with thoſe irregularly formed, where force muſt be irregularly applied, and frequently in too great proportion.

Moſt of the paſſages to the River Thames require conſiderable attention with regard to this particular object.

OBSERVATIONS

Reſpecting the Application of Strength.

THE human frame, when trying to exert its utmoſt force, ſpontaneouſly curves each ſinew; the toes and feet approach each other; the foot itſelf forms a curving line, and the beſt formed legs involuntarily bow themſelves, and form curving lines from the waiſt to the ground.—A ſimilar motion has place in the upper part of the frame, the arms and hands combine in ſimilar curves, and could our obſervation extend to the whole moveable frame, there ſeems no doubt but that the internal texture varies equally with the external ſurface, and making the ſpine the centre,

tre, all ſpontaneouſly form in ſegments of varying circles, ſo as to combine the utmoſt power of exertion the frame has capacity for.

This remark is in labour applied to uſe only in one point as a rule, yet it is one where much of exertion is requiſite, and that is in mowing.—Thoſe accuſtomed to that employment, ever chuſe the ſcythe proper for them, by its point when on the ground, being of equal height to the heel, as is the hip-bone of the intended mower, and the handle placed to hold by is alſo ſimilarly meaſured.

This rule is juſt, admitting all force exertible, moſt eaſily at the baſe, where the ſpine connects the lower and upper parts of the human frame, and hence the height of the ſhaft in all ſpades, ſhovels, hacks, hammers for breaking of ſtones, &c. ſhould by each workman be ſelected agreeable to this particular rule, attention to which, would it is apprehended, facilitate labour in conſiderable degree, except in thoſe inſtances where the workman is employed in a contracted ſpace, which requires deviation from the rule.

A ſimilar rule would, it is apprehended, apply to all machines moveable by horſes or other animals, whoſe centre of action and of force apparently is governed by ſimilar laws, as is that of the human frame, viz. the junction of the upper and lower parts of the frame,

frame, hence, were it not for the inconvenience of loading and unloading, from a higher place than is uſeful for the human form, all carriages ſhould at the centre of the axle, be exactly of ſimilar height to the partition of the horſes frame where the thigh joints move, and the traces uſed to fix him to ſuch carriage ſhould be ſo placed, as to keep them in ſtraight lines from the centre of the axle to the point of exertion, thereby, as in crane work, giving the greateſt facility to exertion, which is ſuppoſed to have place when horizontal lines roll upon circular frames.

Barriers on Turnpike Roads.

ALTHOUGH unconnected with the art of road making, yet as barriers are neceſſary for the receipt of tolls, it may be of utility to ſtate, that the gates uſed for that purpoſe, are generally made more weighty than is requiſite, a form ſuppoſed to compriſe ſufficiency of ſtrength with lightneſs of conſtruction is therefore given, and the utility of putting a covering or cap upon the iron work ſuſtaining the ſame, being found of conſiderable advantage as a guard againſt the ruſt, conſequent on the expoſure of iron to the air, dew or rain, ſo the hangings of the gate repreſent the ſame, as properly there placed.—Indeed ſuch precaution ought to be adopted in all iron hinges for doors. gates, window ſhutters, &c. whenever expoſed to the influence of weather, this ſlight addition keeping

keeping them in a ſtate of more equal ſuſpenſion, in conſequence of guarding from irregular movement occaſioned by ruſt.

TURNPIKE HOUSES.

THE windows of thoſe ſhould curve out externally to give the greateſt poſſible look out, and the places for beds be ſo contrived as to enable the bar-keeper to get up and to the bar, with the leaſt poſſible inconvenience.

ON HEDGES.

PREJUDICES eſtabliſhed by long habit, are overcome with great difficulty.—That it is ſo, is in no caſe more obvious, than in the article alluded to; an univerſal idea prevails amongſt hedgers, that hedges ſhould be placed upon a bank, that ſuch bank ſhould have a ditch at the ſide thereof, and that the earth thrown therefrom, each time neceſſity requires its cleaning, ſhould be plaiſtered around the roots and ſtems of the plants, to give them a warmth and nouriſhment of which true reaſon never taught the want.

Experience ſhews evidently, that trees thrive beſt upon a dry ſurface nearly level; their roots ſpread equally around, and extract the nouriſhment which nature intended them. They are thus defended from condenſed or rarified air, and kept in the proper ſtate of health required to promote vegetation. Ditches on ſuch

ſuch ground are not neceſſary, their repair is expenſive, the thickneſs left generally for their banks is not ſufficient to prevent the roots of trees from penetrating through, and the tender fibres expoſed to froſt in winter, or to heat in ſummer, contract and ſhrivel up, become incapable of acquiring ſufficient nouriſhment, and what is yet frequently more detrimental, communicate the hence ariſing maladies to the parts better defended, and deſtroy millions of plants, which, but for this erroneous cuſtom, would have been an ornament to the ſoil and uſeful to each ſucceeding generation.

Where the ground requires drains covered ones are the moſt proper ones, yet they are beſt made at ſome diſtance from the ſides of fences.

White thorns, which are the moſt uſeful for fences, ſhould be ſet in ground dug well over, and freed from weeds, the quantity of four in a yard is fully ſufficient, and they ſhould ever be ſet ſingle, as enabling the dreſſer to get more readily to clean them, when planted they ſhould be laid in looſely, the roots well covered, and the earth preſſed thereto, ſo as to give nearly the denſity of earth in its general ſtate.—The greateſt care ſhould be taken to keep them free from weeds, to do which will require two or three dreſſings annually.

Their

Their leading ſhoot ſhould not be ſhortened until the hedge is of the deſired height, but the ſide branches ſhould, from their earlieſt growth, be ſo trimmed as to reſemble an egg ſet up on the broad end, as by this medium we beſt acquire the deſired ſtrength.

The intention of nature ſeems ever to aim at producing a tree with ſpreading upper branches, whoſe ſhade, intercepting the dew and rain, bereaves each of the under-ſhoots of the moiſture neceſſary for their growth. Whilſt man for his uſe, as fences, requires the baſe ſtrong and cloſely guarded to prevent the encroachment of animals, whence it becomes neceſſary for him to counteract the general law of nature, and by ſo doing, admit the rain and dew to have equal acceſs to every part of his intended fence, which can only be attained by the propoſed medium.

Although the white thorn be the beſt, yet the hornbeam, the beech and the birch will each make good fences if this rule is attended to; but the want of thorns as a guard, takes much from their defenſive capacity againſt animals.

Should any one be ſtill inclined to keep up ditches where the ſtate of the ground does not require draining, then the ſloping form moſt generally uſed is not the proper one, but a bank formed with curving lines, as in the figure on the plate, diminiſhing from a baſe of three to one, ſuppoſing a ditch made on each

ſide, or the one half of a curve ſo formed, when embanked againſt the adjoining ſoil, and from its baſe upwards, externally covered with ſward, which ſward would, under this curve, be capable of ſuſtaining itſelf, and not liable to crumble or moulder, as is the caſe with thoſe moſt generally made.

The form of a fence cut properly is alſo given on the plate, its baſe thirty inches, the height five feet nine inches, and its rounded top twelve inches.

This fence is adequate to every deſirable ſtrength for reſiſtance, and fences cut in ſimilar proportions from their earlieſt growth, will feather down to the ground, and prove a guard againſt every the ſmalleſt animal.—They gain added breadth each year, if not kept carefully cut, which may be done by means of ſhears, a long ſcythe-like bill, or any hedging-bill, kept ſharp, and habit will ſoon give facility in clearing conſiderable ſpaces in a day.

Experience proves that both beauty and cheapneſs are acquired by attention to thoſe rules, and the reaſon is, that we thus obtain every advantage which the medium of rain or of dew affords, and that equally to every part where wanted.

To prevent water from reſting on any of the cut ſtems, the ſame ſhould ever be cut upwards, if with the bill or ſcythe, as thus the ſurplus water can be moſt readily quitted, which might elſe occaſion damage.

Each

Each projecting ſhoot, from the earlieſt growth, whoſe tendency is to extend beyond the wiſhed for curve ſhould be cut off, at whatever ſeaſon they ſhew ſuch tendency; there will be no reaſon to apprehend danger to the plant, and nature ſoon fills up each vacancy; in conſequence of that regular ſupply, the roots and branches give from their equalized capacity of gaining nutriment.

Short as thoſe rules are for the formation of fences, a ſtrict attention thereto will ſoon prove their utility, and add conſiderably to the beauty as well as durability of thoſe uſeful guards to property.

The THOUGHTS of Mr. BEATSON On ROADS, &c.

Which are publiſhed in the Firſt Volume of the Communications to the Board of Agriculture, ſuggeſting ſeveral Variations which the Author deems it requiſite to note, he hopes the following will not be deemed improper ones.

WOODS if not acceſſible, of how little value—Lands ſimilarly placed, how uſeleſs.

Thoſe urge ſtrongly the neceſſity of new roads.

In China the executive power attends to the roads, as likewiſe to canals.

Where private intereſt is the ſpur, the community is generally beſt ſerved.

Defects

Defects in chuſing ſurveyors, which certainly are of much importance.

All the ſurveyors of townſhips where much is to do, ſhould be permanent ones, with ſalary.

The party views which often change the proper line for roads,

Are too frequently true, and require more ſtrongly the attention of the neighbouring owners, and that impartiality, which ſhould diſtinguiſh Britons.

The remarks of extra ſums received at toll bars.

Unfortunately not well founded to the author's knowledge, the increaſing price of labour too frequently ſurpaſſes the increaſing rate of receipt.

Canals, the attention of government and the advance of the funds therefrom.

Little likely to lead to good, and aſſuredly often to miſchievous application.

Waſte Lands.

The theory of their improvement ſmiles to the view; the practice, where not applied with prudence, frequently leads to immenſe expence and little utility, were the public purſe to be the acting agent, rarely other than the latter would be the reſult; the evil which does moſt ſerious injury after incloſure, is the impoveriſhment of the ground in too rapid a degree, and which occurs too frequently.

Chat

Chat moſs and Trafford moſs,

Although aſſiſted conſiderably by the aid of a canal, yet poſſeſs in themſelves the baſe of improvement independent of ſuch aid, were art properly applied.

Tracts of fine land waſte.

In the mixed ſtate of agriculture and manufacture, in which this kingdom abounds, where are the added hands at preſent attainable to attend the culture, when even the incloſed lands have conſiderable difficulty to procure them, where they, as well as the incloſed lands, allow the opportunity of tempting advantage; it is rare that the ſuppoſed profit attracts not adventurers or parties ſufficiently attentive, to ſeize the probable profit.— The increaſing capital of the community, as alſo its population will progreſſively introduce new incloſures and added cultivation.

Waſtes in Scotland exceeding ſeven millions, in England more than fourteen millions of acres.

Theſe, although exceſſive in extreme will progreſſively diminiſh with the increaſe of population and wealth, the latter increaſing moſt rapidly, by advancing the price of labour, becomes in degree a prevention to incloſure, as enhancing the neceſſary outfit before the adventure becomes productive.

Prior

Prior to the formation of new roads the levels ſhould be taken, the obſtructions noted, and the convenient acquiſition of materials attended to, as much depends on the facility of acquirement; the baſe of the road, its freedom from ſurplus water, alſo require attentive obſervation, clayey ſoils the worſt baſe except moraſs.

FORM of ROADS,
As Convex, Concave or Plane.

CONVEX Ones, properly made, the moſt uſeful, as the arch is the moſt durable form.

Concave, can only be of uſe locally and very few parts are capable of admitting ſuch form with utility.

Planes, might poſſibly be of uſe in very warm countries, and with ſtoney or gravelly baſes. In the moſt of Europe, particularly where clay conſtitutes any conſiderable portion of the ſoil, their uſe is inadmiſſible from the conſequent abſorption of moiſture, and the incapacity in winter of quitting ſuch abſorption.

UNEQUAL HEIGHTS
Very juſtly ſhewn to be improper, as the weight muſt reſt unequally.

The Plan No. I. improper in the extreme, as laying the materials equally moiſt as the ſoil at the ſides, and giving no facility to quit the abſorbed moiſture.

No.

No. II. ſtill more injurious, as leaving a deeper baſe liable to ſimilar inconvenience.

No. III. with added inconvenience, except where thoſe ſcarce local ſituations occur, where the waſhed ſurface can diſcharge its puddled mixture, without quitting the uſeful part of the materials.

Page 137. The theory of the foundation of roads, being moſt uſeful when moſt inclining to clay, erroneous in the extreme.

Becauſe no ſoil is ſo abſorbent, and its point of ſaturation in proportion to weight, exceeding that of ſand ten times, of lime five times, conſequently, in ſuch proportion improper, were the other ſoils placed in equally applicable lines for the intended road, the elevated ſides of his plan improper, and the baſe in no meaſure an advantageous form. No underſtratum where the road is well made can quit the water, as all roads well formed, are of a ſurface ſo denſe, as to admit none or very trifling abſorption, conſequently it is only on the ſurface ſuch moiſture can be quitted properly by means of ſide drains, &c.

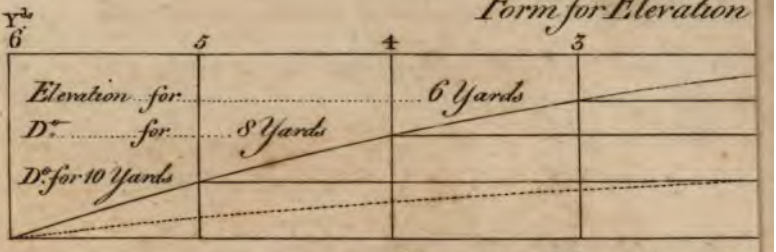
Page 139. The plane improper from its incapacity to quit moiſture, and the certainty that if made as it ought, no abſorption can take place from the upper-ſtrata or covering whilſt firm and compact, to the underſtrata uſed in its conſtruction.

ELEVATION

ELEVATION of PAVEMENT.

THIS rule, omitted before, is laid down, for the breadth of two to four yards, as requiring only one inch; for ſix yards one inch and three quarters; eight yards three inches and a quarter; ten yards five inches and three quarters, and for twelve yards eight inches, agreeably to the ſcale in the plate.

Form for Elevation



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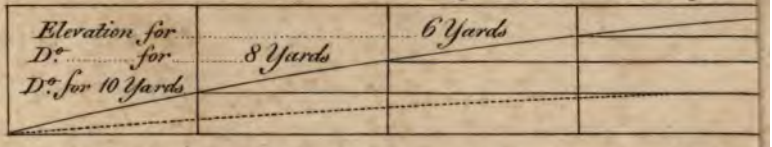
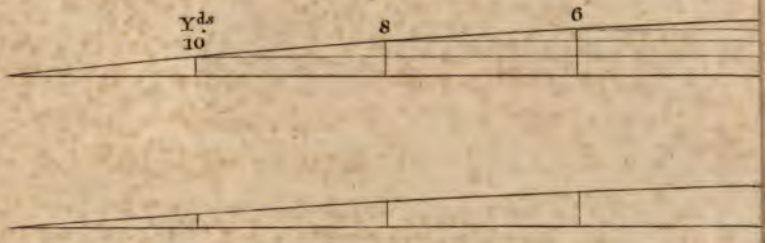


The Elevation is proper, The Length of an Inch represents a Yard, as
as obtained in one distance, would require the space of three; when on its
twelfth of its measure.



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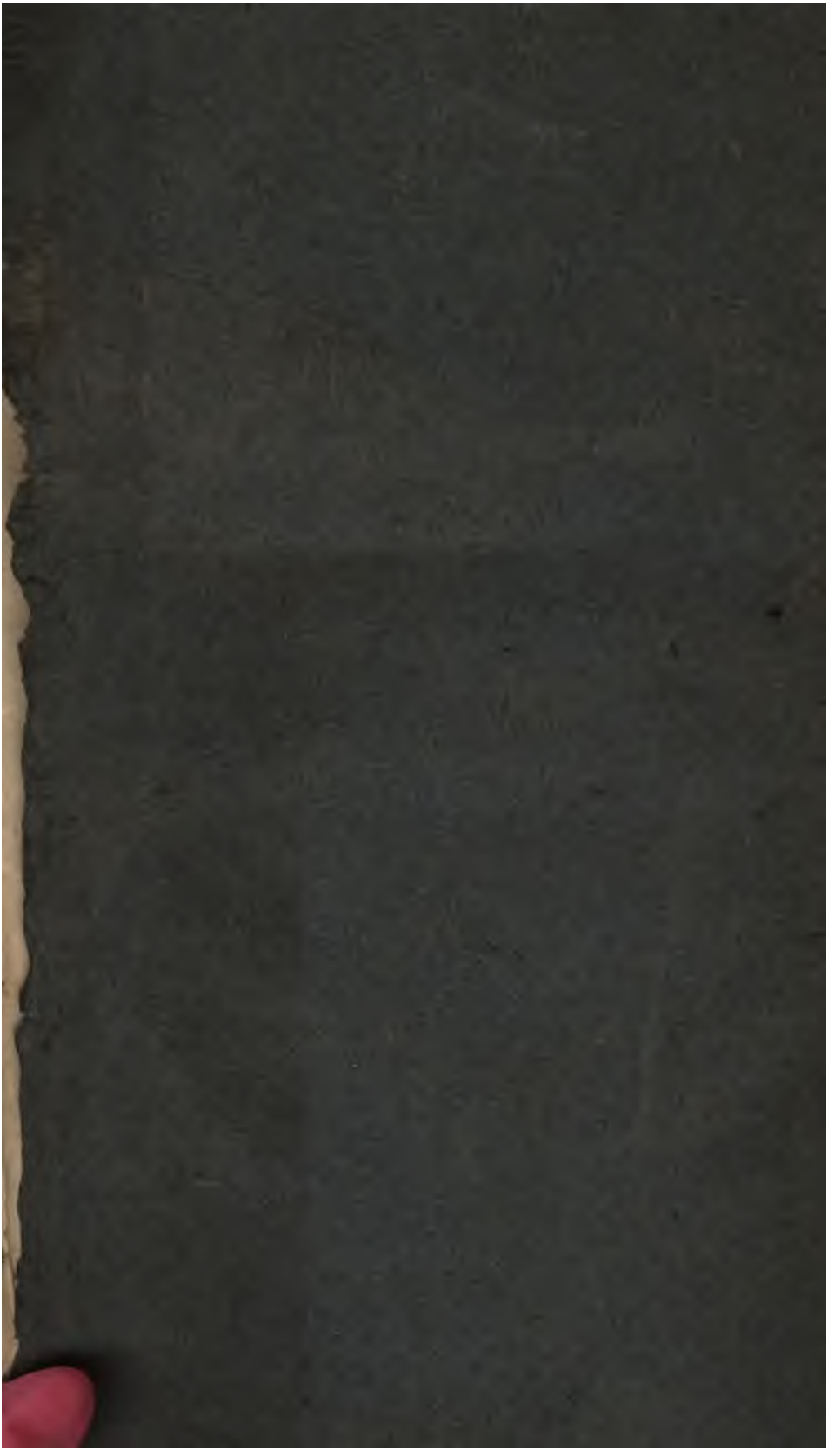
Errata, 18 page, for *of* read *off.*

*** To obviate the ſurpriſe which may have place on reading the extent to which the varying materials of ſand, lime and clay, may poſſibly be ſwelled out on complete ſaturation, (page 30.)—The author deems it neceſſary to note, that ſuch extenſion is calculated, on the ſtatement made by the firſt philoſophers, of the capacity of abſorption inherent in each ſpecie, and their bulk compared with the comparative one of water.

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